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The public promotion of wind energy in Spain from the transaction costs perspective 1986–2007

Yannick Perez [a], Francisco Javier Ramos-Real [b,*]

[a] Université Paris-Sud 11, Groupe Réseaux Jean-Monnet ADIS, Bureau C 310, 27 Avenue Lombart, Fontenay aux Roses F92260 France

[b] Departamento de Análisis Económico, Facultad de Ciencias Económicas y Empresariales, Campus de Guajara, Universidad de La Laguna, La Laguna, S/C de Tenerife 38071, Spain

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ABSTRACT

This paper analyzes the success of wind energy in Spain from 1986 to 2007. Certain special characteristics have emerged in Spain that provide credibility to the feed-in tariff (FIT) device to promote this energy source. To explain this success, the analysis will focus on the intrinsic characteristics of FIT using the concepts of the transaction cost theory (TCE). Nevertheless, in this framework, special attention is placed on the role that specific political and institutional factors have played in providing stability to this instrument. Thanks to an early start and an on-going and generous FIT device, wind energy promotion for electricity has become a political success story in Spain. The main implication of this analysis is that this success is mainly due to the trade-off between stability and flexibility in the use of Spanish FIT.

Contents

* Corresponding author. Tel.: +34 922 317110; fax: +34 922 317204.
E-mail addresses: yannick.perez@u-psud.fr (Y. Perez), frramos@ull.es (F.J. Ramos-Real).

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1. Introduction

Since the nineties, governments have instituted voluntary renewable energy sources (RES) development policies with the aim of preserving a set of collective goods, climate stability, the local environment and energy security. The policy's objectives have been particularly ambitious in the field of electric generation: if we take the case of the European Union members, the share of "new" renewables in electricity production has to increase from 1 to 8% of the total electricity production on average if the voluntary objectives adopted by the 2001 directive on renewable promotion (European Commission, 2001) are to be met. In order to reach these objectives, significant compensation devices have been implemented to promote these technologies. But, there are other political and institutional factors in the energy sector which condition the development of renewable energy sources, such as the industry's promotion policies and technologies on renewable energy.

Government support is necessary for renewable energy sources in electricity (RES-E) because, although desirable from a social welfare perspective, their private costs are not competitive in the power generation systems dominated by large electrical generation plants. Three reasons account for the bias against RES-E in the electricity market: (i) environmental costs are not adequately internalized for conventional electricity generation technologies, (ii) the absence of economies of scale on costs, due to the small size of the plants[1] and (iii) the random nature of the intermittent production of some major sources of RES (wind power, mini-hydraulic) which creates negative externalities. Failed attempts at using systems of voluntary purchases of green electricity by consumers, as well as direct investment subsidies and demand-side strategic deployment policies, have emerged as the instrument of choice in most countries.

The significant renewable penetration rates experienced in some countries and less successful in others have attracted the attention of academics and policy analysts, see Blok [1]. One of the most interesting cases is the Spanish one, as Spain has been one of the countries where the economic instruments to support and promote RES-E have had the most success. This success, nevertheless, has not been shared equally among the different sources of renewable energies, with wind energy having enjoyed the highest degree of development, while the photovoltaics and mini-hydroelectrics have shown more modest growth. This development of wind energy meant that, in 2004, Spain was the second country in the world (after Germany) in installed capacity (8155 MW) and a leader in the construction and operation of wind farms.

Much consideration has been devoted to the importance of the risks faced by renewable generators in OECD electricity markets. In this sense, the financial implications derived from the market and policy changes affecting the generators are of great importance for investors. Moreover, risk reduction is an important criterion in evaluating support mechanisms for renewable electricity. Wiser et al. [2] distinguish between two types of risks. Market risk is related to the fact that these technologies can be brought forward by market-based instrument[2] and regulatory risk is related to the fact that renewable markets are created by policy mechanisms subject to changes in policies priorities and governments. Many authors have analyzed the influence of risks for renewable electricity from the point of view of investors as Dinica [3] and Awerbuch [4]. According to Agnolucci [5], this analysis contributes to the opening of the black box between policy and policy results.

In this paper we are going to analyze the success of wind energy in Spain from 1986 to 2007. From our point of view, Spain offers special characteristics that provide credibility to the feed-in tariff (FIT) device to promote this energy source. To explain this success, we will focus on the intrinsic characteristics of FIT to protect the investors from the financial and regulatory risk using the concepts of transaction cost theory (TCE). In this context, we will pay special attention to the role certain political and institutional factors have played in providing stability to this instrument. Among others these have been: the role of the regional political institutions, the promotion of a National Wind Energy Industry and the FIT device's coherence with the usual rent sharing mechanism in the Spanish electricity market.

To this end, this paper is organized as follows: in Section 2, the attributes of transactions associated with the development of RES-E compensation instruments are analyzed, which will serve to examine, in Section 3, the characteristics, advantages and drawbacks of FIT to promote RES-E production; in Section 4, we will describe the Spanish regulatory and institutional framework in which the evolution of renewable energies, and particularly wind energy, has taken place; in Section 5, we will analyze the success of public promotion of wind energy in Spain from the point of view of TCE. The paper closes with the main conclusions.

2. The attributes of transactions associated with the development of RES production

2.1. Theoretical framework

According to the framework introduced by Finon and Perez [6], from a transaction cost economics perspective, RES-E instruments can be interpreted as a governance structure shaping transactions between the public authority (government or a regulator), the RES-E producers and the obligated buyers. The main goal of this contractual scheme is to provide long-term guaranteed support to attract investors. The TCE also sheds light on the contractual relationship between the government and RES-E producers, given the evolving costs of new equipment on the one hand, and the political risk of discretionary changes on the other.

An analysis of the choice of regulatory instruments designed to promote the development of RES-E for the supply of collective goods relies on the same concepts as the analysis carried out in TCE terms by Goldberg [7] on regulations for the control of natural monopolies in public utility industries. He introduced the concept of "regulatory contract" in order to explain how the contractual delegation of responsibilities to public utility monopolies through

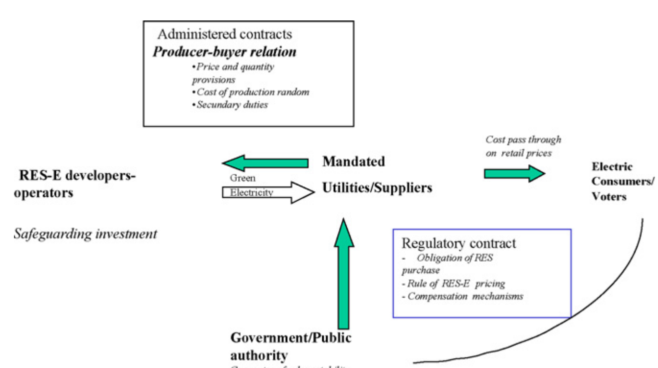


Fig. 1. General governance structure for promoting RES-E. Source Finon and Perez [6].

[1] This aspect is debatable for certain RES-E technologies, as the biomass electricity which could benefit from economies of scale in the supply of the biomass up to a certain size.

[2] These are risks associated to price of fuel; to its availability; to the demand for electricity or to the fact that generators may not be able to deliver the agreed quantity of electricity, among others.

Table 1
National Choices and changes between institutional devices for the promotion of RES-E

Feed-in tariffs (or assimilated)	Bidding (contracts with pay-as-bid rule)	Exchangeable quotas (vertical integration or long-term contracts)
Germany (since 1995)	UK (1991–2001)	USA (17 states with exchangeable renewable portfolio standards) since 1999)
France (since 2001)	France (1996–2000)	UK (since 2002)
Spain (since 1995)	Ireland (1995–2003)	Italy (since 2002)
Portugal (since 2001)		Belgium (since 2003)
Ireland (since 2004)		Provinces in Australia
Denmark*		Austria (minihydro)
Netherlands*		Candidates: Sweden, Denmark, Netherlands

Source: Finon and Perez [6].
* With de-fiscalization.

regulatory oversight is more feasible and efficient than operating a franchise auction solution for the monopoly.[3]

The regulatory contract obliges a set of agents (electricity suppliers for the most part[4]) to purchase RES-electricity from new RES-E plants. The purpose of the regulatory contract is to create safeguards for the RES producers and obligated buyers in order to entice investments in RES-E by the former and to organize, *de jure* or *de facto* for the latter, the recovery or the compensation of the extra-cost in the tariffs or prices being paid by all the electricity consumers.[5] Fig. 1 shows the trilateral relationship between Government, Utilities and RES-E investors.

The regulatory contract between the public authority and the obligated purchasers specifies, in part, the contractual relationship between RES-E producers and purchasers (reducing the freedom of parties to define their contractual arrangement or administered contract in volume and price). Moreover, the regulatory contract also defines the pricing conditions of grid connections for the plants to be built in remote areas. In deregulated electricity systems, it also defines the economic responsibility of balancing the costs supported by the electricity system operator for the real time electricity with the weekly programmable production from intermittent renewable sources.

In terms of designing an RES-E regulation for establishing indirect subsidization of production via the setting of purchase obligations, the government has a choice between three instruments: FIT, BI and EQ. Each corresponds to a specific regulatory contract between the public authority, obligated purchasers and developers.[6]

FIT forces electricity distributors (or the incumbent suppliers in a spatial area) to purchase electricity from any new RES-E plant in their service area and pay a minimum guaranteed tariff per kWh. BI auctions RES-E projects and forces local electricity distributors (or the incumbent supplier in a market system) to buy electricity from the successful plants through a long-term contract on the basis of bid price in the reference design (or the marginal price in some countries). EQ introduces future obligatory targets for electricity suppliers to buy either green electricity directly from the RES-E producers, or green certificates issued to RES-E producers, with targets being defined in terms of a percentage of their electricity deliveries. In Table 1, we show the National Choices and changes among devices to promote RES-E around the world.

2.2. The regulatory contract and long-term stability

At the regulatory contract level between the public authority, producers–investors and obligated buyers, the TCE perspective casts light on the "credibility" of new regulation in an institutional environment. With the RES-E instruments, investments in RES-E plants are strongly specific to the regulatory contract which gives concrete expression of the policy of promoting green electricity production. Consequently, the construction of RES-E installations depends heavily on the credibility of the public authority's long-term commitment, regardless of which of the three regulatory instruments is chosen.

TCE suggests a general need for stability in any long-term contract, making them less incomplete through the inclusion of price flexibility clauses and provisions for renegotiation, such that contracts can withstand changes in the contractual environment [9]. Incompleteness in an RES-E regulatory contract results from both the complexity of the environment in which it is formulated, and uncertainties over future developments, including those involving learning effects. It also stems from the endogenous evolution of technologies with the help of support-stimulated learning. Flexibility of the regulatory contract is important, however, in that it allows for durability of the instrument and maintains an environment favorable to investment in new RES-E facilities.

In the early 1990s, Levy and Spiller [10] and others[7] worked on an application and extension of the new institutional economic framework in [9,11,12] under conditions of credible public policies. In Spiller's system, the credibility of network industry reforms is defined as the capacity to provide competitive stability of commitments, and it depends first on the design of the Regulatory Instruments, and second on the short-term nature of the institutional environment.

In other works, Perez [13,14] Glachant and Perez [15] developed the basic transaction cost economics *ex ante ex post* contractual

[3] Franchise bidding is the market solution proposed by Demsetz [8] in order to suppress the *ex post* control on the franchised monopoly by a regulator and the classical regulatory capture problem. Demsetz demonstrates that the selection of franchise contracts by bidding under the criteria of price and quality of service proposed to consumers would be sufficient, as consumers can thereafter negotiate with the successful utilities individually.

[4] The obligation is defined in relation to the distribution grid operators. In a monopoly, they are the local, regional or national monopoly suppliers. In a market economy, they are the incumbent suppliers who maintain ownership of the distribution networks. The obligation to purchase could be imposed on the electricity consumers (as in the Netherlands for instance), but in fact it is only symbolic, given that as consumers they must delegate their obligation to their supplier or distributor in order to simplify the transactions, with the exception of a few, large consumers.

[5] The payment of the extra costs of new RES-E productions is shared by all electricity consumers. If electricity price increases are kept to an acceptable level (between 0.1 and 0.3 c€/kWh in the European countries, compared to an average final price of 7–10 c€/kWh), this allows for increased support for new RES-E projects.

[6] In order to simplify the analysis, we ignore regulations based on voluntary agreements to purchase green electricity by electricity distributors, large consumers or households. This instrument has high transaction costs (negotiation, *ex post* renegotiation) because of the weakness of the property rights, which are not offset through any economic benefits provided to investors in RES-E, unless other significant supports, such as tax credits, are granted.

[7] Levy and Spiller [10,16] on telecommunications reform, Guasch and Spiller [17] on reforms to various network industries in Latin America; Spiller and Vogelsang [18] on Telecommunications and Spiller and Martorell [19] and Holburn and Spiller [20] on electricity reform.

problem as it applies to reforms: in fact, Spiller's model is logically flawed by the impossibility of guaranteeing a perfect regulatory contract *ex ante*. This classical contractual problem introduces the necessity for an *ex post* set of solutions, and also for flexibility to account for unforeseen events. This need for flexibility to correct imperfections in the initial agreement raises the question of the trade-off between commitment and flexibility. In our estimation, this trade-off has to be managed through regulatory instruments.[8]

3. The features of FIT and the protection of RES-E investors

3.1. The regulatory contract

In a FIT system, the key elements of price and quantity are completely defined by the regulatory contract, unlike in the two other instruments [21]. In terms of governance structure, the obligated agent acts for the public authority assigned to purchase the green electricity produced by new RES-E plants in its area. This type of mechanism offers the most clarity and simplicity in the producer–purchaser relationship, in that it defines most of the contractual terms between the parties [21]. By establishing and controlling almost all the relevant aspects of the producer–purchaser agreement, transaction costs are greatly reduced. Each producer–buyer contract is defined *ex ante* in price for any produced quantity. With regard to volumes, the purchase obligation implies the obligated companies do not know *a priori* the quantities they are to accept in the future.[9] It also implies that, in real time, they must assume the balancing costs related to the random nature of production in wind power and mini-hydraulic RES-E plants.

In a monopoly, the extra-cost of RES-E purchases are recovered by passing it on through retail tariffs; this ensures the indirect subsidization by all electricity consumers. In a market economy, if the incumbent suppliers who bear the obligation are in competition, there are two options. Cost recovery is obtained through a special fund financed by a tax on every kWh transported, and thus passed mechanically to all consumers equally, as in France and Spain. An alternative solution is a mechanism of cost compensation between obligated regional companies, generally the incumbent suppliers, which do not bear the same burden because of spatial differences in the installation of RES-E capacities in their respective geographic areas, as in Germany.

The FIT system, with its regulatory imposition of a contract with an obligation to purchase, a guaranteed purchase price, and those lasting beyond the payback period, offers the most protective conditions for producers, all risk of hold up being suppressed by these conditions form the buyer's part. No negotiation is necessary to sell electricity, search for buyers or set up the contracts. So the inherent costs to the FIT device are very weak for the RES-E producers. The contractual relation, when clarified, only deals with secondary duties: the costs of adjusting to the system, the settlements, the measurement system and the technical specifications.

Table 2
Disparities of wind power installed capacities within the European union (at the beginning of 2004)

Countries	Installed capacity in kW per 1000 inhabitants
Denmark	586.8
Germany	178.1
Spain	162.7
The Netherlands	57.6
Austria	51.2
Luxembourg	50.3
Ireland	50.1
Sweden	44.8
Greece	37.1
Portugal	30.1
Italy	15.7
Great Britain	10.9
Finland	9.8
Belgium	6.8
France	4.3

Sources: Reiche [30].

The FIT system most directly exposes the RES-E producers to the regulatory risk, since there is no need for private contracts. This risk lies in eventual discretionary changes in tariffs and purchase obligations for existing and developing facilities. The initial political commitment to tariff stability for a period of time is not a sufficient safeguard in and of itself. In some countries, private contracts between investor–producers and obligated purchasers provide additional protection for the investors for a minimum contractual period covering part of the pay-out time of the equipment, as is the case in Spain [3]. Hence, while the regulatory contract was short (5 years), the administered contract was much longer.

3.2. The performance of FIT

The choice of regulation is made by governments so as to frame the transactions associated to the supply of a set of collective goods on the basis of new RES-E generation. The objective of the public authority is to encourage the development of the RES-E units by private agents with the support of subsidies on the RES-E (FIT and bidding system), or by the quota constraints applied to suppliers. But other factors are of importance to the public authority as well, such as collective cost control or the development of a National Industry, among others. Collective cost control will result in research on incentives to achieve efficiency by the choice of a device including elements of competition or by rule of rent restrictions.

FIT is the device which offers the lowest transaction costs, and has been considered very effective, especially for wind energy in some countries, like Spain, Denmark and Germany (see Table 2).[10] But it is not best suited for effectively reducing collective costs. In the other two devices, the public authority controls the quantities to be developed on one side, and the competition for winning contracts or the best purchase opportunities submitted to the quotas, acts as incentive on cost reduction.

The FIT system is the most favorable for stimulating technical progress by encouraging innovation and learning on the part of

[8] As Perez [14] has shown, special attention has to be paid to the credibility definition of the network reforms as the "capacity to guarantee the stability of commitments while allowing the necessary evolution of the rules of the game, if this flexibility will not be the expression of stakeholders' opportunistic behaviour."

[9] A crucial question is the time lag of the FIT. In practice, several options exist, going from a fixed period (5 years in Spain before 2004 and 15–20 years in other countries), to a number of working hours like in Germany (only the first 10,000 h) or an explicitly decreasing rate according to productivity gains, like in Denmark (−2% per year). In theory, these systems try to manage a trade-off between a too favorable scheme which induces large investment but too high a long-term social cost, and a too restricted scheme which, in turn, does not induce enough investment to satisfy the objective. This long-term commitment is the crucial problem for investment, because policies are supposed to change more frequently according to the democratic changes in government compositions or agendas. This situation opens the door to discretionary changes in the initial public contract and the risk is borne more by the investors.

[10] According to Agnolucci [5] the parameters used to asses the effectiveness of the policy are unclear. They could be the amount of capacity (kW) or electricity (kWh) (although it is likely to be other important factors like the costs per kW or kWh). However, it can be argued that policies failing the criteria below are unlikely to be effective.

Nascent National Constructors. As the rent of the producer investors is large, it can be shared with the manufacturers. Being in a position to benefit from the rent increase will result from the incremental innovation to be introduced by the latter. It has no coincidence that the top three wind power equipment producing industries are in Germany, Denmark and Spain.

The public authority can establish high tariffs in the first stage of the RES-E life cycle, but incompleteness of the regulatory contract in the FIT system can be arranged so as to target of installed RES-E capacity can be defined to that effect, beyond which the tariffs are recalculated. The pricing can be conceived with an *ex post* adaptation rule in relation to the learning factor and technical progress effects. In this sense, by providing different levels per technology, FIT promotes different types of technologies, while the others devices prioritize the cheapest technologies.[11]

Nevertheless, as Del Río and Gual [22] point out, ''*to guarantee a generous FIT is not sufficient to increase RES-E deployment*''. In Spain, the stagnation in the promotion of PV, biomass and small hydros results from a series of elements unrelated to promotion mechanisms, such as administrative procedures, grid connection, unfamiliar technologies, etc. Breukers and Wolsink [23] show that ''*implementation of wind energy in the Netherlands has been ponderous, due to an emphasis on centralized policy-making, and an underestimation of issues of spatial and environmental planning and problem of local acceptance*''. Agnolucci [5] thinks that the most important factors influencing the diffusion of RES-E policies in the Netherlands have been the lack of coherence and the lack of a strong coalition supporting renewable electricity. This author points out that in some instances coalitions supporting a specific technology could act to the detriment of other technologies.

4. The Spanish case from 1986 to 2007: constant legislative incentives for RES promotion

In this section we describe the legislative and institutional framework in which the promotion of renewable energies in Spain has been developed.

The data on trends in RES-E deployment show that wind energy has experienced impressive growth, though the same cannot be said for all types of renewables. Table 3 shows the favorable evolution of the average price for the different renewable energies between 1998 and 2005, with a slight stagnation in 2003 and 2004. Note the emphasis on the compensation provided for photovoltaic solar energy, despite which this technology has not developed as originally hoped. In 2005, the average purchase price in the wholesale generation market was 6.24 c€/kWh, that is to say, 31% below the compensation received by each kWh of renewable origin.

The RES-E system enjoys significant efficiency in terms of installation (with 8000 MW installed in wind power between 1995 and 2004). The combination of good wind locations and generous FITs resulted in profitable investments. According to IDAE [24], the internal rate of return for a wind farm, with a useful life span of 20 years, 2350 annual hours of operation and subject to regulated tariff, is about 7% after taxes, and the biggest risk factor is the sale price evolution.

In the following sections we study the elements that have allowed the promotion of wind energy to flourish in Spain. We will begin by making a historical analysis of the legislation and the institutional framework that have constituted energy policy in Spain.

[11] Del Rio and Gual [22] points out that cost inefficiency of FIT diminishes when it is adjusted for different technology cost reductions.

Table 3
Renewable energy prices between 1998 and 2005

Source	1998	1999	2000	2001	2002	2003	2004	2005
Renewable	6.87	6.74	6.71	6.64	7.35	6.38	6.42	9.07
Solar	6.99	20.89	22.45	24.97	28.63	30.81	36.73	39.91
Wind	6.81	6.68	6.72	6.69	7.38	6.24	6.30	9.07
Small-hydro	6.92	6.80	6.76	6.57	7.33	6.59	6.66	8.84
Biomass	6.37	6.33	5.94	6.52	7.12	6.56	6.55	8.87

Source: IDAE [24].

4.1. Precedents: from nukes to RES

Spanish energy policy changed its course from one directed to the growth of nuclear energy in the eighties, to one whose aim is the promotion of renewable energies as we look beyond the year 2010.

National Energy Plans (PEN) was a classical tool in Spain for defining the energy policy following the energy crisis of the seventies. The PEN, approved by the parliament, stipulated the anticipated demand, the sources of production and the nature of the investments which would have to be made to meet demand. The last PEN emphasized the promotion of renewables in keeping with the public's concern over environmental issues.[12]

In 1991, the new PEN included a 1991–2000 energy savings and efficiency plan, setting overall targets for energy production from renewable energy sources to 1.1 Mtoe/year by 2000, increasing renewable electricity production to 4.2 TWh/year and thermal energy to 0.5 Mtoe, comprising a 35% increase from biomass, 9% from small hydro, a planned target for solar collector area for the year 2000 of 400,000 m^2/year and an installed wind capacity of 168 MW.

In 1999, the Spanish government adopted the Promotion Plan for Renewable Energies ('Plan de Fomento de las Energías Renovables en España'), calling for a doubling of the renewable energy share in the primary energy supply (excluding hydro-electric) from 6 to 12%. The main areas considered by the plan were biomass, wind, small hydro, solar and urban solid waste. This same objective is featured in the latest plan for renewable energies 2005–2010, which would imply that 30% of the electricity will be generated from RES-E in 2010.

4.2. The Spanish FIT device in RES promotion 1980–2007

The introduction of FIT for various classes and capacities of technologies followed the planning period that started in 1986. That year, the 'first renewable energy plan' set targets for production from renewable energy and targets for private and public investments in renewable energy systems.

Between 1980 and 1994, RES-E was introduced into the market thanks to third-party financing by IDAE and investment subsidies based on guaranteed government purchases for individual projects (only for a specified target group defined in the RD 82/1980 Energy Conservation Law). Since 1994, through the so-called 'Royal Decree 2366', the RES-E device has been defined in the context of mandated contractual purchases of electricity by companies and of the rules of buy-back tariffs. The average tariff to be paid by distribution companies is based on avoided generation, transport and distribution costs. As Dinica [3] points out, in this period the FIT has been quite small and the price risk very high because,

[12] The cause of this energy policy reorientation is the EU's environmental legislation, though it has met with wide social approval. In this sense, the national environmental organizations unconditionally support renewable energies, though they occasionally oppose local implementations (wind energy sites).

Table 4
Exclusive competences of the Spanish State in economic legislation

Art. 149.1.10: international Taxes for import and export and external trade
Art. 149.1.11: monetary systems, foreign currencies, change. Economic basis of loans, bank system and insurances
Art. 149.1.13: bases and coordination of general economic planification
Art. 149.1.14: state finances and state debts
Art. 149.1.21: train and transportation system for more than one autonomous community; the global framework of communication, post and telecom as air, underwater and radio networks
Art. 149.1.22: public authorisation for building electricity production or transportation systems who implies and effect in more than one autonomous community
Art. 149.1.23: fundamental legislation on environmental protection. The autonomous communities have the right to issue more legislation on only additional requirement

Source: Bon and Moderne [31].

although the purchase price is guaranteed by law, no details on the design of the price and its evolution have been specified.

Motivated by the deregulation of the industry by the LSE 97, the policies of RES-S promotion are moving toward market rules while trying to support certain regulatory stability. RD 2818/98 gave renewable energy producers a choice between either high fixed feed-in tariffs or a system with a lower premium on top of the market price.[13] Reformulation in 1997 ensured a payment equivalent to 80–90% of the retail rate (almost 8 US cents/kWh) to wind energy producers; FIT lagged a minimum of 5 years behind[14] and price support was to be revised periodically.[15]

In March 2004, new feed-in tariff regulations were adopted (RD 436/2004), giving renewable energy producers two remuneration options: sell output to the distributor at a regulated (feed-in) tariff; or sell output directly in the market at the market price plus an incentive and premium, in addition to a capacity payment. Until this change in policy, most producers chose the fixed tariff system, simply because it provided a better deal and less uncertainty over future income. In Appendix A, we compare the two mechanisms and show that the trend toward market-based mechanisms in the Spanish system is both logical and, for the time being, costly.

This RD also tried to achieve two other goals: firstly, a stable compensation system through lasting and transparent regulation, indexing the system of premiums to the new method for calculating the reference electricity fee (REF) provided by RD 1432/2002;[16] secondly, to increase the profitability of those renewable energies that have not developed as expected, such as photovoltaics or biomass, and reducing the risk for investors by guaranteeing support levels throughout the useful life of the installations. Nevertheless, by keeping the FIT intact, Spanish policymakers showed that they would not surrender to policies that could jeopardize rapid market diffusion.

The FIT device in Spain has occasionally been criticized as too expensive. The cost of RES-E support for consumers increased from 270 M€ in 1998 to 620 M€ in 2003 (4% of the total electricity sector turnover) and represents a cost of 0.26 c€/kWh for consumers (compared to a final electricity price of 3.02 c€/kWh). A comparison of the different studies done for Del Río and Gual [22] concluded that in other countries, where the deployment of RES-E has been most effective, similar levels of support have been offered. Additionally, their work shows that the FIT under RD2818 has led to significant environmental benefits and does not involve excessive cost to the consumer in relative terms.

5. The success of the FIT device from the point of view of TCE

5.1. The stability of the FIT device in Spain

In this section, we analyze the factors that explain the successful development of wind power in Spain from a TCE perspective. From our point of view, this success is explained by the particular characteristics of the FIT mechanism presented in previous sections. The Spanish case has specific features which allow us to understand the satisfactory operation of the model and its credibility for the agents implied. These elements made it possible to overcome the mechanism's key weakness: regulatory risk.

Initially and, on a purely general basis, we can state that the optimum solution for governing transactions between producers and purchasers must offer clarity and simplicity. The transaction costs of Spanish FIT are acceptable because the support system is very simple and regulation required practically no bureaucracy to be implemented for wind energy [22]. However, we consider that the principal reasons which explain the success of the policy for the promotion of wind energy are the stability and the flexibility of the mechanism under the circumstances which were present in Spain. The stability of the mechanism is also explained by economic and political reasons.

So as to interpret the evolution and the changes in renewable energy legislation and the stability of the compensation system particularly for wind power, let us consider the important role played by the main agents involved in the process: the Central Government, the Governments of Spain's Autonomous Regions, the Electric Companies and the RES-E manufacturing industry.

5.2. Stability explained by economic rent sharing

In Spain, the use of flexibility within the stable framework of the FIT system has been achieved and has resulted in the global credibility of the device. Also contributing to its credibility is the annual adjustment of the feed-in tariff premiums compared to the wholesale price and the relatively short duration of the purchase obligation (5 years versus 12 or 15 years in other countries), which facilitates the flexibility of the device.[17] The arrival of a new government in 2004 also led to a revision of the device to improve its forecasting for RES-E investors.

[13] Thus, the RES-E device was integrated by the electric industry deregulation law of 1997. It is integrated into the particular regulatory niche of the "system of independent production" created beside the new regulatory system of "ordinary" electricity competition. This RD supported the obligation for the purchase of decentralized production by the large regional producer–distributors, which can be reinforced by direct subsidies on the investment and tax subsidies at the central and provincial level (as in the region of Galicia, where more half of the installed capacity comes from wind power).

[14] Distributors were only obliged to sign 5-year contracts (art. 17, RD2818), which is a shorter period than necessary to recover investments.

[15] Both updated annually since 1999 by the Government in line with the variation in the average electricity sale price, and revised every 4 years.

[16] Changes in support levels are another factor affecting risks to investors. This has been a negative aspect of the FIT under RD2818. Annual revisions of the support granted have not been based on a transparent objective formula and have been deemed unpredictable and arbitrary. RD436 reduces the risk for investors by guaranteeing support levels for the useful life of the installations [22].

[17] The involvement of financing agents, electricity companies and, often, regional public authorities as wind project investors led to de facto private contracts for wind electricity in excess of 5 years.

This stability of the mechanism in the long-term was ensured by the attribution of rents to the incumbents.[18] FIT did not attract real hostility from the electric companies because the mode of regulation allows all overcosts to be passed on via electricity prices and tariffs. This was not called into question during the right-wing government period between 1996 and 2004. This stability is based on the understanding between large companies and their principal ally, the Ministry for Industry. The reason behind this understanding is twofold.

Firstly, the policy of RES-E promotion compensates for the impossibility of investing in nuclear energy since the late eighties, and is seen as a way to fulfill the objectives of Spanish climate policy. Secondly, the device is coherent with the usual rent mechanisms in the Spanish electric market: indeed, the revenues are collected by the RES-E producers, who are mainly the subsidiaries of the major electricity operators, which in turn benefit from the electric system's considerable rents (stranded costs, price making on the wholesale electric market).[19] Lack of coherence with the regulation and traditional rent mechanism in the electricity market might decrease the interest of utilities in renewable generation [5].

Another important factor affecting the stability of the device emerges from the creation of an RES-E manufacturing industry. This new industry limits the possibility of transforming the device into one which would leave less rent and create fewer opportunities for industrial development, as is the case in Germany. Hence the refusal in Spain to consider a shift to the quota device which was discussed in Germany in 2000, despite the European policy toward harmonization which aims at unifying the RES-E devices between countries.

The institutional atmosphere in Spain thus creates an effective incentive structure for RES-E developers by ensuring a stability which is corrected through the adaptability of the device in place. This situation, however, is no guarantee that the structure will remain intact. In Denmark, where a sizeable wind turbine industry developed as a result of a generous policy combining buyback tariffs and the defiscalization of green electricity, subsidies for new projects were stopped when the right-wing government was elected in 2002.

5.3. Stability explained by regional political institutions

Basically, in terms of the institutional environment in the Northian sense, Spain has a hybrid system of government centralization and a type of limited federalism (Weingast [27]). The government plays an important role in the industrial policies and decision making processes involved in regulatory design in strategic sectors, as in the regulation of the electricity industry; it can legislate by decree. The regionalization of the political institutions in Spain acts to asymmetrically reinforce the public policies defined at the central level, in that it does not allow for the scope of the policies initiated at the central level to be reduced, but it does authorize the increase in public commitment and regulatory support provided by the Provinces (Perez [13]).

The 1978 Spanish Constitution, while reserving for the state exclusive rights over general economic planning and legislation governing the energy system, gave the country's 17 Autonomous Regions far more leeway than before in developing administrative procedures and planning provisions related to, among other matters, the environment (IDAE [28]. The constitution recognizes the right of the autonomous communities to have financial autonomy "for the development and enforcement of their authority". These communities receive revenues directly and indirectly from central government sources as well as from their own local taxes, special levies and loans. Several of Spain's Autonomous Regions have been acutely aware of the opportunities presented by wind power in terms of regional industry policy and employment. According to Del Guayo [29], there exists a tension between the local authorities and the central government over the former's desire for increased sovereignty. Article 149 of the Spanish constitution of 1978 establishes a framework of 32 exclusive responsibilities of the central government (see Table 4).

This article does not give the autonomous communities much say over the management of the Spanish electricity sector. Their competence is limited to three areas: the management of consumer complaints at the local level; the introduction of additional local taxes relating to provisions for environmental protection; and finally, the right to follow a regional policy of energy promotion in keeping with the PEN. For RES promotion, the last point is crucial, because it leaves local authorities the option to build and operate a RES strategy.

It should be noted that Spanish Provinces have a right to veto any change in policy involving RES-E promotion, a right that is guaranteed by the Spanish constitution of 1978. Their jurisdiction over economic and industrial issues allows them to foster local economic activities. Such was the case in Galicia and Navarre (see Appendix B) and the development of a local wind turbine manufacturing industry, which have benefited from subsidies aimed at developing local employment.

6. Conclusions

In this paper, we have used the transaction cost framework to understand and classify the public devices used to promote RES-E technologies. We have also analyzed the empirical success of wind power development and the FIT device in Spain from this analytical perspective, but taking into account other key factors within the political and institutional framework in Spain.

In our opinion, the success of wind energy is explained by certain specific characteristics of the FIT mechanism in the Spanish model, which allow for an understanding of the model's operation and its credibility. These characteristics made it possible to overcome the principal weakness of the mechanism, namely, the regulatory risk, and allowed for long-term stability. This is explained by economic, as well as political, reasons, among which are: the role of regional political institutions, the promotion of the National Wind Energy Industry and the FIT device coherence with the usual rent sharing mechanism in the Spanish electricity market.

The RES promotion policy through the FIT device was validated in the last RD 661/2007. This new legislation introduced limits to the maximum and minimum prices that

[18] "*The allocation of economic costs and benefits will influence the way in which interest groups relate to the policy, in particular those who are bearing a large share of the costs or are given a small fraction of the benefits*" [5].

[19] According to Eikeland and Sæverud [25], among incumbent energy producers, both major national companies Endesa and Iberdrola are now investing heavily in renewable energy. Iberdrola, Spain's second largest energy company, has become the biggest owner of wind farms in the world (more than 3000 MW), with the Navarre wind-power developer EHN currently ranked third [26]. Endesa, with an installed capacity of more than 1100 MW, was by June 2005 the owner of around 20% of the total installed wind power capacity in Spain. Hence, Spain's renewable policies seem to be more about additional opportunities than the redistribution of resources among national players. This is of course related to the gap between growing energy demands (nearly 6% growth per year in recent years) and the poor domestic supply situation. Unlike the UK, Spain does not have a strong domestic fossil fuel industry that might feel threatened by strong support schemes for competing energy sources. Spain's small oil and gas industry contributes less than 1% to domestic demand for each of these fuels [26].

could be set by RES-E investors. At first, the associations of producers noted some changes that could generate risk in the recovery of the investment, but later modifications (after negotiating with the government) led to the most important elements of previous decrees being retained.

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Appendix A. Feed-in tariff regulations (RD 436/2004). Two retribution options

A.1. Option (a) the regulated tariff

Retribution (a) = reference electricity fee (REF) + premium for reactive power (+8% to −4% of the Tariff) − penalty deviation.

• Relative medium regulated price

Relative medium regulated price for wind power	5 years	Next 10 years	Until the end
Installed capacity < 5 MW	90%	90%	80%
Installed capacity > or = 5 MW	90%	85%	80%

- Premium for reactive power: basically the producer will be paid if (1) he gives reactive power in peak hours and (2) he absorbs reactive power in off-peak hours. All the definitions of peak in off-peak hours according to the regional variables are set in BOE (1995) and are clear cut.
- Penalty deviation: producer will paid a deviation penalty only if is installed capacity is at >10 MW and if the deviation between forecasts and realizations are up to 20% of the forecast. The cost of the penalty is =10% of the REF × by the monthly calculated deviation.

A.2. Option (b) market-based retribution

Retribution (b) = spot market price + (capacity payment) + bonus (40% of REF) + incitation (10% of REFD) + premium for reactive power (+8% to −4% of the Tariff) − penalty deviation.

- Capacity payment: in Spain all the classical producers receive an availability bonus for being ready to respond to demand. Due to the specificity of wind production (weakly predictable and intermittent), wind producers will only receive the bonus when they are really producing.
- Premium for reactive power is the same.
- Penalty deviation is for all producers, and the cost of the penalty is 10% of the spot market prices managed by system operator.

Conclusion: as long as the spot market price is so high due to fuel price, this second scheme is much more favorable to RES producers and explains why 94% of them have taken the "market base price" in 2007 (the other 6% are very small producers).

In term of credibility, this scheme is also chosen because it is possible for each producer, every year, to switch from one scheme to the other according to their preferences.

Appendix B. The Navarra example [25]

The Navarra example is striking; more than 45% of total energy production in 2003 came from wind power. In return for authorisation of wind-farm projects, local governments have often required that developers keep a large share of investments in the local economy and contribute to local employment. The success of Navarra in coupling environmental and industrial affairs serves as an example to yet other regions seeking to emulate the model in order to attract industrial investments based on wind power. Aggregated to the National Level, the sum of regional success stories had by 2003 created a sizeable wind-power industry with more than 47,000 jobs (12,000 direct and 35,000 indirect). Spain is now home to the world's second-largest manufacturer of wind turbines, Gamesa; and is the currently largest wind-park developer and constructor in the world (EHN, incorporated in 2004 into the Acciona Group), with up to 500 smaller companies supplying components.

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